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## Proposed Egyptian Standard of Spraying Application of Pesticide and its Alternatives on Certain Orchard Pests

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### ABSTRACT

Modern application techniques ensure that Pesticide reaches the target in satisfactory coverage and therefore reduces losses and environmental pollution. According to the Food and Agriculture Organization FAO / UN (2001) safety and quality standards for pesticide sprayers do not exist in all countries and even the existing standards for this type of equipment are often inappropriate for many countries.

The present study is specified for orchards which could be considered as a nationalized version of the international standards applied already in the developed countries after re-adaptation to our local conditions, orchard varieties, climatic and social conditions, etc.

This investigation depends on local data about this subject were collected by means of questionnaires covering five governorates in the delta and upper Egypt. The second part is the proposed standard and recommendations supporting the bio-efficacy of best control in a clean environment.

The standard was divided from the general scheme of work to be followed strictly by the pest control team in order to achieve the required satisfactory results and explanatory guidelines, consists of four parts: 1- Legislation of the pesticides, spraying techniques; 2- Determination and adjustment of proper spray parameters and calibration; 3- Technical requirement of sprayer/atomizer and test procedure and 4- Obligatory (compulsory) check of the spraying machines and its components as, well the assisting ground services. The most important recommendation to achieve satisfactory pest control results is to take immediate and serious action towards the official legislation of the whole aspect of the spraying application techniques used in Egypt, which include:

Certification of spraying machines, licensing of the applicator, and obligatory checks on spraying operation and machine performance; to define and adjust proper spray parameters capable to give the required optimum coverage on the treated fruit trees.

### INTRODUCTION

The cultivated area with fruit trees in Egypt is exceeding 1.8 million feddans representing 9.8% of the total cultivated areas during the year 2018. The annual income of fruit production was 9.36 billion Egyptian pounds representing (2.84% of the total

agricultural production was 329.3 billion Egyptian pounds. (Ministry of Agriculture, Egypt 2018). Studies indicated clearly that, the recent spraying techniques used in orchards are unsatisfactory and could be responsible for insufficient bio-efficacy, which oblige farmers in many times to increase the chemical dosage and/or to repeat the application more than the recommended one to assure maximum protection possible for their production. That means a waste of money, effort, and time, in addition to a more contaminated environment with toxic-chemicals.

Even the technical recommendations given by the Ministry of Agriculture in 2016 defined 100 liters / feddan as a fixed rate of application for all kinds of fruit trees, irrespective of their geometry foliage structure, nature of the infestation, physical properties of the sprayed solution, seasonal climatic conditions ....etc.

The successive rising of pesticides costs and the tendency to apply minimum chemical dosage possible towards a cleaner environment was making the accurate application more important than ever before. In other words, optimizing the misused application techniques should provide to a significant increase in fruit production from all ways had been made like Jeppsns (1953), ripper (1955) Morgan (1964), Morgan, (1969) and Mapother, (1970) Carman and Jeppson (1974) Carm an, (1975) Salyani *et al.*, (1990) Also many investigations were made by thermal foggers on mango trees against fruit flies Hindy *et al.* (1995) and Gazia *et al.* (2019) also investigation was made against phyllocnistis citrella (the citrus leaf miner on citrus Hindy *et al.*, 1999) and means. Many spraying applications of pesticides in orchards since 1995, Food and Agriculture Organization FAO / UN has worked intensively on the formation of guidelines to improve the safety and efficiency of the most commonly used spray equipment. These guidelines were based mainly on the acting American and European references. According to FAO, 2001 safety and quality standards for pesticides sprayers do not exist in all countries and even the acting international standards are often inappropriate for many countries. The present study is the first recorded standard of application techniques specified for orchards in Egypt and could be considered as the nationalized version of the international standards applied already in developed countries after re-adaptation to our local conditions, orchard varieties, pests, climatic and social conditions .... etc.

The principal aim of the standard is to inform manufacturers and sellers of spraying equipment and pesticides farmers, applicators, and agricultural environmental authorities with a practical and consistent quality assurance system in order to maximize the – efficacy of pest control results and minimize contamination with pesticides to the allowable level possible.

This investigation includes two main parts; local data were collected by means of a questionnaire covering representative regions in Delta and Upper Egypt.

The second part of the work is the standard applicable for orchards in addition to a certain supporting recommendation.

## MATERIALS AND METHODS

### **Completion and Analysis of Local Questionnaire Covering Aspects of Orchards Pest Control and Application Techniques.**

Through a preliminary scan of the database (Gabir, 2004) it was observed that the collected data didn't cover precisely the actual local aspects of spraying application of orchards with pesticides in Egypt. Therefore, it seems essential to design a questionnaire for concerned individuals acting in this field. It includes 60 heading questions and/or information needed to cover the majority of data missing in the review of the literature. 210 questionnaire applications were distributed during 2018 in five governorates:

Qalyoubia, Ismailia, Gharbeya representing Delta Nile, and Beni Suif and Fayoum representing Upper Egypt. The collected information was analyzed and presented in table (1) of this investigation.

### Preparation of The Proposed Standard for Orchards:

Taking into account information's given in the review of the literature and that collected by the questionnaires, the general frame of the proposed standard for orchards was created and presented in a part of this work. The standard was divided into two principal items:

The general scheme of work to be followed by the pest control team to achieve the required satisfactory results; and the explanatory guidelines, which indicate the technical structure of the standard in order to support the applicator's capability to maximize operational and biological performance without risking his health or harming the environment. The guidelines consist of three main items: 1- Results obtained from the local questionnaire concerning specific local information about spraying application of orchards in Egypt; 2- The general scheme of work and 3- The explanatory guideline, which consists of four parts: Part 1: legislation of the pesticides spraying techniques, Part 2: Determination and adjustment of proper spray, Part 3: Technical requirements and testing of the commonly-used sprayers and Part 4: Obligatory check of the spraying machine and its components.

**Table 1:** Analysed results of the questionnaire, expressed in percentage and general trend.

Item /Region	Description	DELTA				UPER EGYPT			Grand Mean
		Qalyoubi	Ismaili	Garbeya	Mean	Bani Suif	Fayoum	Mean	
Education level of data collector	Non-alphabet	-	14.2	-	14.2	15.0	-	15.0	14.60
	Primary secondary school	17.0	14.2	30.43	20.54	10.0	25.0	17.5	19.02
	Academic degree	59.0	35.71	34.78	43.16	-	37.50	37.50	40.33
Orchard type	Citrus	82.7	7.6	42.3	44.2	52.5	18.75	35.6	39.9
	Banana	3.4	-	7.69	3.69	-	-	-	3.69
	Olive	-	19.5	-	19.5	5.0	16.6	10.83	15.16
	Mango	4.5	85.9	-	45.2	30.0	29.16	29.58	37.39
	Apple	3.4	-	11.53	4.97	-	2.08	1.04	3.00
	Date Palm	3.4	4.76	-	2.72	12.50	8.33	10.41	6.60
	Grape vine	6.8	3.0	19.2	9.66	5.0	10.41	7.7	8.68
Type of trees	Apricot	-	-	-	-	-	12.5	6.25	6.25
	Evergreen	89.7	100.0	61.5	83.7	90.9	72.2	81.56	82.70
Age of orchard year	Deciduous trees	-	38.46	-	38.46	9.09	27.77	18.43	28.45
	Less than 10	3.4	10	11.11	8.17	28	18.18	23.09	15.63
	10 < 20	24.2	70	61.11	51.77	28	36.36	32.18	42.0
	20 < 30	24.20	20	22.22	22.14	12	28.45	28.72	25.43
	30 < 40	31.10	-	5.55	12.21	20	-	10.0	5.60
	40 < 50	13.70	-	-	4.56	8.0	-	4.0	4.30
Heigh of tree,	50	3.4	-	-	1.13	4.0	-	2.0	1.60
	1.5 – 2	17.24	-	-	5.74	10.0	16.66	13.33	9.54
	2.5 – 3.0	17.24	-	33.33	16.85	60.0	-	30.0	23.43
	3.5 – 4.0	13.79	25.0	55.5	31.4	-	25	12.50	22.0
	4.5 – 5.0	-	-	11.11	3.70	20.0	25.0	22.5	13.10
	5.5 – 6.0	3.4	25	-	9.46	-	25.0	12.5	22.0
	6.5 – 7.0	-	37.5	-	12.50	10.0	-	5.0	8.80
Cultivation Area.m.	10	-	12.5	-	4.16	-	8.33	4.16	4.16
	2.0 * 2.0	6.89	-	23.0	9.96	3.7	-	1.85	5.91
	3.0 * 3.0	-	-	7.60	2.52	29.62	-	14.81	8.70
	3.5 * 3.5	6.89	-	11.53	6.14	-	-	-	6.14
Cultivation area, m.	3.5 * 4.0	-	-	15.38	5.12	7.4	-	3.7	4.41
	4.0 * 4.0	10.34	-	38.45	16.26	14.80	18.18	16.49	16.40
	5.0 * 5.0	68.96	10.0	3.84	27.60	37.0	27.27	32.13	30.0
	6.0 * 6.0	3.40	35.0	-	12.8	3.7	27.27	15.48	14.14
	7.0 * 7.0	3.40	25.0	-	9.46	3.70	27.27	15.48	12.50
	8.0 * 8.0	-	25.0	-	8.33	-	-	-	8.33
10.0 * 10.0	-	5.0	-	1.66	-	-	-	1.66	

Surrounding sensitive area	Bee hive	27.58	15.3	7.69	16.75	90	50	70.0	43.40	
	Poultry	13.79	23.0	-	12.26	-	-	-	12.26	
	Stable	3.4	61.50	-	21.63	10.0	50.0	30.0	25.82	
	Water source	10.30	-	-	3.43	-	-	-	3.43	
	No reply	44.93	0.20	92.31	45.93	-	-	-	15.09	
Pests	Aphid	28.57	25.70	26.60	26.95	34.88	14.58	24.73	25.89	
	Citrus flower worm	-	2.85	3.44	2.09	6.97	8.33	7.65	4.87	
	Purple scale insect	1.78	2.85	6.89	3.84	6.97	-	3.48	3.66	
	Citrus stem borer	-	22.85	13.79	12.21	-	12.5	6.22	9.22	
	Shell scale insect	28.57	8.67	-	12.4	2.32	14.58	8.45	10.43	
	Cotton leaf worm	-	-	7.21	2.4	2.32	-	1.16	1.78	
	Vine fruit worm	3.55	-	10.34	4.61	2.32	6.25	4.28	4.45	
	Red date palm beetle	-	2.85	-	0.95	-	-	-	0.95	
	Fruit fly	37.5	33.9	31.72	34.37	44.18	31.25	37.71	36.04	
Plant disease	Olive insect	-	-	--	-	-	12.5	6.25	6.25	
	Glue trunk of citrus	75.0	4.70	5.55	28.4	43.75	16.12	29.93	29.12	
	Fruit rot of vin & Banana	7.14	-	5.55	4.23	-	3.22	1.61	2.92	
	Apple scab	-	-	11.11	3.70	-	-	-	3.70	
	Banana spotted leaf	3.57	-	-	1.19	-	-	-	1.19	
	Banana spotted leaf	3.57	-	11.11	4.89	-	-	-	4.89	
	Banana apical rosins	3.57	-	11.11	4.89	-	-	-	4.89	
	Blight of Mango flower	3.57	85.7	-	29.75	18.75	38.7	28.72	29.24	
	Powdery Mildew of vine	3.57	-	38.88	14.15	28.12	22.58	25.35	19.75	
Weed	Woolen Mildew vine	3.57	-	27.77	10.44	9.37	12.30	11.13	10.80-	
	Spotted leaf of Olive	-	9.50	-	3.16	-	6.45	3.22	3.20	
	Annual weeds	43.6	39.10	84.61	55.77	36.53	27.50	32.00	43.90	
	Grass weed	10.90	43.4	-	18.10	17.30	20.0	18.65	18.38	
	Bramble	23.60	0.430	7.69.	11.86	19.23	17.50	18.36	15.11	
	Animal pests	Brown Mite	43.4	19.20	40.0	34.2	16.60	5.88	11.24	22.72
		Flatten Mite	4.34	11.50	40.0	18.61	3.33	-	16.65	17.63
		Citrus rust Mite	39.10	4.3	20.00	21.13	36.66	5.88	21.27	21.20
		Mango rust Mite	4.34	46.10	-	16.80	23.3	23.50	23.40	20.11
Bark beetles		-	11.50	-	3.8	6.66	29.41	18.03	10.93	
Birds		8.69	-	-	2.89	3.33	17.64	10.48	6.69	
Rodents		-	7.60	-	2.53	10.0	17.64	13.82	8.12	
Mean of Measuring chemical	Absent	15.0	43.75	-	19.58	-	7.14	3.57	11.59	
Pesticide package	Original	42.3	50.0	53.84	48.7	84.0	60.0	72.0	60.36	
	Licensed local package	53.8	30.0	43.58	42.26	16.0	13.33	14.66	28.46	
	Unknown	3.80	20.0	2.56	8.78	-	26.66	13.33	11.18	
Presence of pesticide label	Present	59.9	80.0	100.0	79.9	100	81.25	90.6	85.25	
	Absent	40.91	20.0	-	20.3	-	18.75	9.37	14.84	
Reading label's data	Yes	78.26	75.0	100.0	84.42	100	100	100	92.21	
	No	8.69	20.0	-	9.56	-	-	-	6.00	
	Sometimes	13.0	5.0	-	06.0	-	-	-	6.0	
Is label's data enough	Yes	77.28	65.0	100.0	80.76	85.71	73.33	79.52	80.14	
	No	22.7	35.0	-	19.24	14.28	26.66	20.47	19.86	
The most important data of the label	Validity	59.3	23.6	41.66	41.52	66.6	77.7	72.21	56.87	
	Application technique	28.1	-	8.33	12.14	7.46	5.55	6.50	9.32	
	Dosage	9.37	76.4	25.9	37.22	-	16.66	8.33	22.6	
	Bio-efficacy	3.10	-	24.10	3.81	25.9	-	12.9	8.36	
Disposal of chemicals empty container	Left in the field	38	-	-	12.66	-	-	-	12.66	
	Reused	28.5	-	-	9.49	4.76	-	2.38	5.94	
	Burning	19.0	33.0	100	50.7	61.9	35	48.45	49.61	
	Into soil	4.70	66.6	-	23.78	23.8	65	44.4	34.11	
	Recycle bin	9.50	-	-	3.16	9.52	-	476	3.96	
Pesticide storage	In store	91.31	95.0	95.0	93.77	70.0	57.14	63.57	78.67	
	No storing	8.69	5.0	5.0	6.22	30	42.85	36.42	21.32	

Source of information for applicator	State extension service	35.28	44	38.78	39.25	45.5	49.21	47.35	43.35
	Pesticide seller	11.76	-	-	3.92	-	6.52	3.26	3.59
	Personal know-how	10.2	12	12.24	13.14	17.6	8.69	13.14	13.14
Source of information for applicator	Experience of others	13.2	8.0	12.06	11.08	4.4	-	2.20	6.64
	Media	5.88	100	13.79	39.89	11.76	8.69	10.22	25.06
	Publications	20.58	18	17.24	18.6	13.23	15.20	14.12	16.36
	Pesticide label	-	6.0	-	2.0	7.35	6.52	6.93	4.47
	Miscellaneous	0.29	2.0	0.86	1.82	-	4.34	2.17	1.20
Source of water for mixing	River	52.94	85.0	58.97	65.63	60	75	67.5	66.57
	Drainage	-	5.0	-	1.6	11.4	-	5.7	3.65
	well	35.29	5.0	-	13.4	-	12.50	6.25	9.84
	Drinking water	11.76	5.0	41.02	19.26	28.57	12.50	20.53	19.9
Timing of treatment	Before infestation	60	10.7	33.3	34.66	13.8	17.64	15.76	25.21
	Just after infestation	32	28.57	42.59	34.38	38.8	41.17	40.0	37.19
	At certain infestation level	8.0	60.7	24.07	30.9	47.2	41.17	44.19	37.56
Disposal of remined chemicals	In side soil	20.8	40.0	64.7	41.83	25.8	27.77	26.78	34.31
	Reused	20.8	-	-	6.93	6.45	5.55	6.0	6.47
	Other purposes	-	5.0	-	1.66	6.45	-	3.22	2.44
	Without remain	58.3	25.0	35.29	38.53	61.29	66.66	63.97	51.25
Applying with irrigation system	Yes	-	33.3	-	11.11	17.39	100.0	95.64	75.60
	No	100	66.6	-	55.5	82.6			
Spray down wind	Yes	95.24	21.0	50.0	55.41	78.5	87.5	83.0	69.21
	No	4.76	78.8	50.0	44.48	21.42	12.50	16.96	30.75
Timing of application	Early morning	95.4	35.0	-	43.46	44.8	37.50	41.15	42.31
	At the end of the day	4.5	65.0	100	56.5	55.11	62.5	58.83	57.67
Ceasing of operation	Temp. < 35 °c	37.93	50	32.2	40.04	43.75	39.47	41.61	40.83
	RH > 60%	6.89	20.0	32.2	19.69	10.46	23.68	17.07	18.38
	In stable air	20.68	11.76	3.38	11.94	12.5	10.52	11.51	11.73
	Air speed < 12 km /h	34.48	17.6	32.2	28.09	33.3	26.31	29.82	29.0
Respray after rain	Yes	47.8	100	100	82.6	76.92	87.5	82.21	82.41
	No	52.17	-	-	17.39	23.07	12.50	17.78	17.59
who apply?	Land owner	16.6	28	8.0	17.53	11.42	-	5.71	11.62
	Ag-worker	33.3	40.0	-	24.4	28.57	36.84	32.7	28.57
	Spray man	50	32.0	92.0	58.0	31.4	52.6	42.0	50.0
	Cooperative extension	-	-	-	-	28.57	10.52	19.54	18.54
Age of spraying applicator	child	-	-	-	-	-	-	-	-
	young	33.3	47.8	46.6	42.5	50.0	68.75	59.37	51.0
Gender of applicator	Man	66.6	52.10	5.33	57.36	50	31.25	40.6	49.0
	Male	100	100	100	100	100	100	100	100
	Female	-	-	-	-	-	-	-	-
	Both	-	-	-	-	-	-	-	-
Number of applicators	One	4.34	21.0	8.33	11.22	38.46	18.75	28.6	19.91
	2.0 – 4.0	95.6	78.9	91.66	88.73	61.53	81.25	71.39	80.06
Experience of applicator	1 -5 year	61.6	26.3	90.0	44.6	40.0	33.3	36.66	40.64
	> 5 year	83.3	73.6	90.6	82.61	60.0	66.66	63.33	73.0
Daily working hours	< 8 hours	38.8	15.0	100	51.29	48.14	31.25	39.69	45.50
	8 hours	44.4	75.0	-	39.81	33.3	56.25	44.79	42.30
	>8 hours	16.66	100	-	38.8	18.5	12.5	20.5	29.70
Presence of protective cloths	Yes	28.3	61.1	41.7	43.77	84.0	56.25	70.12	56.95
	No	71.42	38.8	58.3	56.18	16.0	43.75	29.87	43.01
Type of protective cloths	Mask only	-	-	-	-	27.27	10.0	18.63	18.63
	Glove only	40	5.8	30.0	25.3	-	20.0	10.0	13.3
	Mask and glove	10.0	41.10	10.0	20.4	22.7	20.0	21.4	20.9
	Complete clothes	50	52.9	-	54.3	50.0	50.0	50.0	52.18
Suitability of protective clothes	Suitable	26.7	80.0	28.6	45.1	42.3	55.6	49.0	47.0
	Non suitable	73.3	20.0	71.42	54.91	57.69	44.4	51.0	53.0
Clean of protective clothes	Together with personal clothes	80.	5.0	33.6	39.5	44	45.45	44.72	42.14
	In the field water source will out soup	13.3	95.0	66.3	58.2	36.0	54.54	45.22	51.72
	Not clean	6.66	-	-	2.2	20.0	-	10.0	6.11
Education level of	An alphabet	17.9	-	-	5.95	4.16	13.33	8.74	7.35
	Read and write	60.7	42.85	79.16	60.9	66.66	73.33	69.99	65.45

applicator	Primary secondary school	21.42	42.85	20.83	28.36	29.16	13.33	21.24	24.8
	Academic level	-	14.28	-	4.76	-	-	-	4.76
Waring of neighbors		42.85	40	-	44.41	27.69	35.4	31.58	38.0
Flagging of treated floats		-	16.6	-	5.5	23.07	12.9	17.98	11.76
Presence of persons animals in treated field		57.14	28.5	50.0	45.21	35.38	95.16	40.27	42.14
Consumption of sprayed plants	Immediately after spraying	8.0	-	-	2.66	8.0	-	5.33	4.0
	Few days after application	72	55	-	42.3	36	25.0	30.5	36.42
	After one month	-	-	17.3	5.76	-	25.0	21.5	13.63
	According to regulation	20.0	45.0	82.6	49.2	56.0	75.0	65.5	57.35
Type of spraying machine	Motorized	100	100	100	100	14.8	80.0	47.4	73.7
	Manual	-	-	-	-	85.18	20.0	52.59	52.59
Calibration/adjustment of sprayer	Seasonal	15.3	60.0	76.92	50.74	-	6.25	3.17	27.0
	According to regulation	-	35.0	3.84	12.94	50	31.25	40.62	26.78
	In case of problem	76.98	5.0	19.23	33.7	50.0	56.25	53.12	43.4
	Never	7.92	-	-	2.64	-	6.25	3.17	2.91
Maintenance of spraying machine	Seasonal	20	5.0	32.0	19.0	20	16.66	18.33	18.67
	Periodical	33.3	95.0	52.0	60.11	30.0	27.77	28.88	44.50
	In case of fault	46.6	-	16	20.88	50.0	55.55	52.77	38.83
Number of owned sprayers	One	100	80	87.5	89.16	79.16	93.33	86.24	87.7
	>1 sprayer	-	20	12.5	10.83	20.83	6.66	13.33	12.10
Suitability of filters	Suitable	100	80	91.3	90.4	73.91	73.33	73.62	82.03
	Unsuitable	-	20.0	8.69	9.56	-	6.66	3.33	6.45
	Not present	-	-	-	-	26.10	20.0	23.0	23.0
Lost spray	Dropping	34.2	9.5	37.5	27.06	27.2	62.50	44.85	36.0
	Drift	47.36	90.4	62.5	66.75	68.18	37.5	52.84	59.8
	Evaporation	18.42	-	-	6.14	4.50	-	2.25	4.20

## RESULTS AND DISCUSSION

### Analytical Results of the Questionnaires:

Table (1) shows the analytical results of the questionnaire replies, collected from Delta and Upper Egypt. It indicates clearly that the recent spraying techniques used in orchards are unsatisfactory and could be responsible for insufficient bio-efficacy, which oblige farmers in many times to increase the chemical dosage and to repeat the application more than the recommended one to assure maximum protection possible for their fruit production. That means a waste of money, effort, and time, in addition to a more contaminated environment with toxic-chemicals. In general, no essential differences were found either between results gathered from the Delta region and Upper Egypt or between viourous and area locations. The main in indicators of the tabulated data could be concluded, as follows:

- 1- The education level of data-collector Minority of data-collectors was non-alphabet, half of them were read and write persons. Holders of academic degrees represented 40%.
- 2- Percentage of entirated orchards: The majority of orchards belonged to the evergreen trees group (83%) citrus and mango represented two-thirds of the cultivated orchards, followed by Grap vine, Date palm, and olive (25%). The lowest cultivated fruit trees were Apricot and Apple were (10%).
- 3- Age of orchard: Two-third of the observed orchards are 10 – 30 years old.
- 4- Hight of trees: (80%) of treated trees is ranged between 2.5 – 6.0 meters in height.

- 5- Spacing between trees: More than (70%) of the fruit trees observed are cultivated with a spacing between each other ranged between 4.0 – 7.0 meters.
- 6- Surrounding sensitive area: Beehive and 1 or stable are situated close to orchards subject to be sprayed with pesticides. All data collectors in Upper Egypt gave such statement, while (37%) only declared so in the Delta region.
- 7- Major Pests of orchards: It could be arranged in descending way in accordance with its economic importance and level of infestation insects: fruit fly – aphid – red spider's, scale insects and thrips; Plant diseases: mildew and blight; weeds: Annual and grass weeds; Animal pests; More than (80%) of data collectors considered spider mites as a serious problem i.e. excessive using of pesticides.
- 8- Percentage of infestation on upper / lower surfaces of leaves: 55% / 45%.
- 9- The direction of infestation tendency: East - North (38%), South – West (26%), and No clear tendency (36%).
- 10- Vertical Distribution of infestation on trees: In general, the infestation was concentrated inside foliage at the middle part of the tree. i.e. shadowed and not dry habitat.
- 11- Pesticides used:
- 11.1.- Packages: More than (60%) of pesticides used were originally imported packages, while (29%) were local package under license. The rest were either non-licensed package or unknown sources (11%).
- 11.2.- Mean of measuring dosage: The majority of applicators (88%) used a chemical's tank cover or a simply scaled vessel, while (12%) used no means and measuring visually.
- 11.3.- Chemical label: Percent on the package (85%), whereas (92%) of applicators are reading the label and found its data enough; especially that related to the expiry date and recommended dosage against given pest.
- Unfortunately, no significant interest was given to the application technique data-even if found in the label.
- 11.4.- Disposal of chemicals empty container: By burning (50%), into the soil (34%), thrown in water canals, or reuse for other purposes.
- 11.5.- Disposal of remained chemical: Many applicators consumed the used chemicals totally, without remains. Rest reused in some field or in other purposes (48%) – thrown in water sources (21%) – thread onto soil surface (10%) – into the soil (8%) – other ways (13%).
- 11.6.- Storage: About (80%) of pesticides were kept in primitive stores having a minimum level of safety precautions. Remained applicators were kept chemicals in the home, shadow place out the home, and outside the field.
- 11.7.- Presence of first Aid: Half of the chemical application sites didn't have any proper first-aid facility.
- 11.8.- Applying pesticide through irrigation system:  
A minority of users of irrigation systems applied suitable formulations of pesticides through a sprinkler to the same money and effort. Those users represented (10%) only of the users of irrigation systems observed.
- 12- Source of information: Applicators depends on more than one source of information, such as pesticide seller (57%) – State extension service (28%) – Media (25%) – Pesticide label (17%) – Publications (16%) – Personal know-how (13%) – Local agricultural engineer (12%) – and other minor sources (14%).
- 13- Source of water for mixing pesticides: Mainly river (68%), in addition to drinking water (20%), well (8%), and drainage (4%).
- 14- Beginning of treatment: (40%) of farmers applied chemical treatment immediately after the appearance of any infestation signal. Rests are applying protective treatment before infestation (25%) or at a minimal level of infestation (35%).



- 15- Timing of spraying application: More than one-half of observed applicators selected proper timing for spraying, i.e. early morning after dew evaporation rest of the applicators started application in the early morning, irrespective of climate suitability.
- 16- Ceasing of spraying operation in relation to climatic conditions: 1- In case of air temperature higher than 35 c°, (41%) of applicators stopped operation, 2- In case of relative humidity less than (60%), only (18%) of applicators ceased operation, 3- In presence of stable air, which is not a suitable condition for spraying operation (12%) only ceased spraying and (4) In case of airspeed higher than 12 km/h, more than (70%) sprayed under such windy conditions.
- 17- Re sprays after the rain: The majority of pesticide users repeated operation in case of raining after less than 24 hours since application.
- 18- Method of application: All pesticide applications were applied by means of ground spraying techniques, no ground dusting was observed, even in case of powdery formulation availability.
- 19- Applicator: Most probably, the spray man and / or ag-worker are the orchard applicator-about (80%) – working professionally against money.
- 20- Age, number and gender of applicator: an only young man and man (1 – 4 persons) are orchard applicators. Neither child nor females were found to be involved in this profession.
- 21- Health condition of the applicator. The majority of applicators might seem healthy from a general point of view.
- 22- Experience of applicator: (41%) having 1 – 5 years' experience and rest more or less.
- 23- Daily working hours: (30%) of applicators worked more than eight hours, (42%) eight hours and the rest less than this duration.
- 24- Protective clothes: Half of the applicators worked with protective clothes. The use of a complete set of clothes (mask/gloves/shoes with a long neck and overall) was respected – to a great extent – in Ismailia and Beni Suif governorates, (61%) and (84%) respectively. No positive results were collected from the other governorates, as the applicators tended to use a very simple mask only (59%) or gloves only (6%) or both of them (56%). In general, the used mask was not applying the basic standard in this regard.
- 25- Suitability and cleaning of protective clothes: Two-thirds of applicators stated that their used clothes were unsuitable. The cleaning of multi usable items of clothes was done in the home either with personal clothes (50%) or separately with water and soap (46%). One-third of users cleaned their protective clothes in water sources around the orchard.
- 26- Warning neighbors before application: About two-thirds of applicators didn't do so, while (30%) of them warned neighbors always and (25%) sometimes.
- 27- The presence of persons and / or animals in treated field: Most probably, all operations were done in fields with no presence of persons or animals.
- 28- The presence of a barrier zone between around treated fields and wind speed/direction: Two-thirds of applicators didn't give any attention to such vital factors and the rest with minimal care.
- 29- Consumption of plants sprayed with ag-chemicals (57%) of peoples consumed plants sprayed with pesticides according to regulations with pesticides according to regulations.
- 30- Type of spraying machine: The tendency to use small and medium-sized ground motorized sprayers was clear (79% users) in comparison to knapsack motorized sprayer and manual hand sprayers.
- 31- Calibration/adjustment of sprayer: (43%) of users takes care of calibration of their machines in case of problem occurrence only, whereas one fourth doing it and 3% of them never do the calibration.

32- Maintenance of sprayer: The majority of users didn't differ between maintenance and calibration processes; therefore, the results of the questionnaire were quite similar / or to the previous item.

33- A number of owned sprayer/s: (87%) of owners have one sprayer only.

34- Suitability of filter: About one-third of the required filters were absent or not suitable.

35- Rate of application commonly used: (spray volume): (80 -1200) liters / feddan, with no scientific rules in selecting a rate.

36- Source of spray loss: Due to negligence and lack of knowledge with proper spraying techniques, the dropping of pesticides on soil could be considered as the greatest source of loss using high volume rates HV. On the other side, drift by wind could follow the dropping problem by means of LV, VLV, and ULV rates.

37- Safety precautions: In (27%) of application sites observed, no safety precautions were available. (25%) of applicators didn't know such precautions. In less than half-sites visited minimal primitive precautions were found.

### **The Proposed Standard of Spraying Application of Pesticide in Orchards:**

As seen from the results of the questionnaire analysis it was found, unfortunately, that chemical pesticides are sprayed with various types and sizes of uncourt-fied spraying equipment. In addition, these machines are operated by anyone, irrespective of his qualification and experience in this regard. Therefore, taking into consideration the mentioned indicators and the rich data given in the review of literatures, the Food and Agriculture Organization (FAO) guideline of 2001, US Environmental Protection Agency (EPA) 1990 – 2004 reports and Gabir, (2004) the present standard of Spraying Application of Pesticides of orchards was prepared. It divides into two principal items the General Scheme of work and Explanatory Guidelines, as follows:

#### **The General Scheme of Work:**

An integrated team qualified to realize the standardization of pesticide application techniques. The team consists of specialists in the major fields of orchards production economic entomology, plant pathology, pest control, application techniques and environmental affairs. They cooperate together to diagnose the infestation and define the proper solution leading to the optimum production of fruits. Here in after, the main steps and procedures to be taken by the team:

1- A technical report should be a prepared-on special printed model within 24 hours after recognition of infestation. The report includes the following items: in details

1.1.- Kind of infested fruit trees including variety, stage, foliage coefficient of curling, growth situation for the variety.

1.2.- Nature of infestation: a schematic map should be drawn showing general topography of the orchard shape and area of plots / in feddan, neighboring plantations (kind, stage of growth, and area).

1.3.- Pest/s including economic threshold, stage/instar, level of infestation/population, the habitat of pest (leaf upper side/underside) stem flower, fruit, the position of the plant), the direction of infestation.

1.4.- In case deciding that pest control will be done by chemical pesticide / s in the frame of Integrated Pest Management (IPM).

1.5.- Meteorological in formation, especially air temperature, air stability, relative humidity, airspeed/direction. Possibility of turbulence occurrence range of visibility and dew status.

1.6.- Spraying application technique; more details in the report as follows:

1.6.1.- Operational data: Timing, warning circulation of sprays, duration, barrier zone/s, sensitive region/ s such as bee hives/fishery, poultry farm, animal stable, water canal, open stored-product applicator/worker, choice of proper equipment, preparation, protective

clothes, operation, safety execution, performance, evaluation, training and climatic conditions and type of spraying equipment.

1.6.2.- Ground equipment: (Hand-held Motorized) Small / Medium / Big Sized, hydraulic – pneumatic Rotary- combined vehicle.

1.6.3.- Sprayers: mainly Hydraulic, mist blower, and combinations of the mounted nozzles and electrostatic field application; maintenance of equipment (daily – weekly – seasonally – annually thermal fog equipment in special treatments at certain invention condition (early morning or at the end of the day after sunset).

1.6.4.- Certification of nozzles;

1.6.5.- Obligatory checks of nozzles

1.6.6.- License of the applicator.

1.6.7.- Calibration: Adjustment of spray parameters like flow rate (l / min), swath width (m.), working speed (km / h), spray height (m), and rate of application (L / fed), and droplet spectrum /coverage (deposited droplets on treated target).

1.6.8.- Safety precautions: Rules, regulations policy ..... etc.

1.6.9.- Pollution: Sources (dropping / falling run-off, evaporation, volatilization, drift, washing and dumping.

1.6.10.- Concerned Authorities and their its role:

The department of spraying technology (DST), Ministry of Agriculture; to observe the fulfillment of the explanatory guidelines and will be charged with ensuring that pesticides spraying techniques do not pose unreasonable risks to the public and to the environment.

1.6.11.- The central laboratory of pesticides (CLP) Ministry of Agriculture; to observe the 1.4. the general scheme.

1.6.12.-Suggested new office for coordination between these authorities and for eventual development (OCD).

### **The Explanatory Guide Lines:**

This guideline explains the technical structure of the standard gives operational information about its fulfillment on fruit orchards. This will support the applicator informative capability to maximize the performance of the pest control application without risking his health and without harming the environment. The Guideline consists of the main parts.

2.1- Legislation of pesticide spraying technique

2.2.- Determination and adjustment of proper spray parameters and calibration calibers.

2.3. Technical requirements of sprayer and test procedures.

2.4. Obligatory check of the spraying machine and its components.

### **1- Legislation of The Pesticide Spraying Technique:**

One of the vital aspects of the standard to be fulfilled immediately as follows:

#### **A-Certification of New/Second – Hand Sprayer:**

Spraying machines of any size and type used in spraying toxic or non-toxic chemicals outdoor must be certified before its usage. A. certification license will be given to the machine's owner indicating its official serial number and the expiry date of the license. The duration of validity will depend on the category (size/weight/type) of the sprayer. The given weights and revalidation of the license will be issued by the same department on basis of satisfactory results of the machine's performance after carrying out calibration tests by DST.

#### **B-License of The Ordinary Applicator (OA):**

Persons who would like to action spraying operation of toxic and or non-toxic chemicals outdoor must bear a personal Applicator License giving him the right to do so by means of definite categories of spraying machines for the sake of himself and /or other

parties/parties. The Licensed Applicator must pass a theoretical and practical exam prepared and approved by the Ministry of Agriculture. No license will issue for persons/ess than 18 years old or more than 55 years unqualified or no healthy or pregnant/ lactic ant women.

### C-Certification for Individual Sprayer Types:

A further important principle is that certification of proficiency in the use of application equipment must be granted for specified applicator types. Validity period operator proficiency certificates should have a validity of no more than 3 years, where upon users must either be re-assessed or demonstrate that they have under taken sufficient training in any area specified by the regulatory authority to remain on the register of certified operators.

### D-Certificates of Competence and Control (CCC.): -

The certificates of competence are very important and the scheme authority must protect its value and integrity. The certificate proves that the user is competent to use the equipment or to carry out the tasks. The aim of the regulatory authority should be to establish and maintain the integrity of the scheme by ensuring appropriate, consistent, and uniform assessment /test procedures so that the equipment owners and users consider the resulting certificate to be valuable because it provides the applicator (s) in crop protection; potential benefit to the activity for which the applicator (s) is used; improved employment opportunities for the candidate, increased public confidence.

### 2-: Determination of Proper Spray Parameters and Calibration:

The following outlines the most important parameters affecting spray quality and the steps of calibration and adjustment of the spraying equipment:

- 1- Rate of application/spraying volume (L. / fed.)
- 2- Flow rate / Delivery (L / minute)
- 3- Swath width (RW) (meter)
- 4- Working speed (km / h.)

The following equitation (Gagir, 2004):

$$Q \text{ (L / minute)} = SW \text{ (m.)} \times VO \text{ (km / h)} \times T \text{ (L / fed.)} / 252$$

Spray quality: According to (Gagir, 2004) the spray quality of a candidate nozzle is defined in terms of airborne and deposited droplet spectrum, expressed in number (NMD), size (VMD), and coefficient of uniformity. The recommended spray quality and rate of application for the main orchard pests were listed in the following tables 2 and 3.

**Table 2:** Spray quality recommended for certain orchard pests

Droplet spectrum in Um	Pest	Climatic conditions*
Very fine and fine (>100)	Fine flying / rested insects and spider mites	Inversion climatic condition
Fine and medium (100 – 250)	Sucking insects of small sizes and the majority of orchard diseases	Optimum
Medium and coarse (250 – 350)	Lepidopterous caterpillars	Normal
Coarse V. coarse (> 350)	Weeds	Bearable

\*Spraying operation ceased when: Air temp. is more than 35 C° or R.H. is less than 65% or wind velocity exceeds 12 km.

**Table 3:** Rate of application (Liter / feddan) recommended for Certain fruit trees

Fruit trees	Height, m*	Rate of application L / fed.
Citrus	6.25	100
Mango	2 – 10.5	200
Vine	1.5	50
Olive	4.75	100
Apple	7.2	100
Banana	5.0	100

\*Collected records from the local questionnaire as: Average size – Mid age – Most cultivated variety on wires.

### 3. Technical Requirements of The Common Spraying Systems:

The principal technical requirement of the spraying systems commonly used on fruit trees could be represented as follows:

2.3.1. Handheld hydraulic sprayer

2.3.2. Vehicle – Mounted and Trailed sprayers: a-Pressure/flow control system .b-Liquid retention in the sprayer.

2.3.3. electrostatic, Pneumatic vehicle-mounted and tailed sprayer

2.3.4. thermal foggers

I. manual fogger.

II. fogger mounted on cars.

2.3.5. Pneumatic rotary motors

I. knapsack motor sprayers.

II. Pneumatic rotary motors mounted on car's

### 4- Obligatory Check of Spraying Machine and Its Components:

This check should be done also in our country, on any type and size of certified sprayers applying pesticides outdoor, without prior notification to the owner and/or user of the checked sprayer using not certified machine irrespective of its size and / or type in applying pesticides is prohibited and illegal. Sprayers check will include 1- its calibration, 2- nozzle type and its discharge, 3- spray pattern uniformity, 4- speed checks, 5- pump performance, and 6- plumbing arrangements. An obligatory check must be a primary management consideration done by a qualified inspector licensed by the department of spraying technology. Users should also learn from proper application methods, chemical effects on equipment, and correct cleaning and storage methods for their sprayers. Satisfactory results can be obtained, when these six components are used in the right combination and chemicals have been properly mixed. Manufacture's catalog is usually the main guideline, but fine-tuning of a sprayer is the operator's responsibility. Sprayers should be calibrated every time a different pesticide is applied due to variation in liquid physical properties. In addition, a sprayer should be recalibrated at least every other few days when in continuous use.

### Conclusion and General Recommendation:

In addition to the proposed standard and towards the achievement of satisfactory orchard pest control results under the umbrella of a cleaner agricultural environment the following general recommendations could be concluded:

- To start looking seriously at applying and evaluating the present suggested standard practically. Notes should be taken about advantages a shortcoming obtained in practice, to be considered in the next version on this standard;
- To take immediate and serious action towards the official legislation of the whole aspect of the spraying application techniques in Egypt, which in clued: certification of spraying machines, licensing of the applicator and obligatory checks on spraying operation and machine performance;
- To define and adjust proper spray parameters capable to give the required optimum coverage on the treated fruit trees which can lead to good pest control results with a minimum acceptable level of environmental pollution. This includes regular evaluation of the performance of equipment by means of an up to date spray target information in accordance with the calendar and lifetime of sensitive components especially nozzles;
- The media should draw attention to this vital subject-directed to concerned individuals and institutions in both state and private sectors to understand and evaluate the role played by the application techniques in increasing agricultural production, as well in protecting the environment; and the safety of spraying applicators.

- To ask the concerned international and national organization such as FAO, WHO, European Union's related committees and EPA / USA, as well as, associations of big manufactures of pesticides and spraying machines/nozzles to support research work and institutions involved with the standard;
- To encourage the arrangement of training courses and the organization of seminars, meetings, and conferences on national and international levels to exchange ideas;
- Applying oils-under suitable technical and climatic conditions-as carrier or as a pesticide appealed greatly for various reasons;
- To save chemicals applied, by means of shields over a single nozzle or boom; closed-circuit system offered on direct contact with these chemicals;
- To warn the public, farmers, beekeepers, and persons working inside the sensitive areas surrounding the treated target, before the execution of operations. Red flags should be placed clearly on these areas.
- To take all necessary measures possible towards the reduction of dropping and drift of sprayed chemicals.

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## ARABIC SUMMARY

### مقترح لنموذج مصرى لتقنيات تطبيقات المبيدات وبدائلها على بعض آفات البساتين

محمد عبد العزيز هندی – رحاب عبد المطلب عبد المقصود دار – مرفت عبد المنعم الجنيدى  
معهد بحوث وقاية النباتات – الدقى – الجيزة

تضمن طرق التطبيق الحديثة وصول المبيد الى الهدف المعامل بدرجة تغطية مرضية مما يؤدي الى تقليل التلوث البيئى. وطبقا لتعليمات منظمة الاغذية والزراعة فاو (سنة 2001) حيث اصدرت توصيات بشأن المعايير النوعية القياسية لالات الرش بالمبيدات على البساتين . ولم تصل تلك التوصيات لكل البلاد ، وحتى وجود تلك المعايير لهذه المعدات الارضية عادة ماتكون غير ملائمة للظروف المحلية لبعض البلاد.

تختص هذه الدراسة الحالية بالبساتين والتي تعتبر بمثابة ترجمة وطنية للمعايير الدولية المطبقة حاليا بالبلاد المتقدمة وذلك بعد اعادة ملائمتها طبقا لظروفنا المحلية ، واصناف البساتين المنزرعة والظروف الجوية بمختلف المناطق – والاحوال الاجتماعية الخاصة ببلادنا ..... الخ.

لذا اعتمد هذا البحث على معلومات محلية بخصوص البساتين فى مصر ولقد جمعت هذه المعلومات من خلال استمارات استبيان مصممة فنية لمعرفة اساليب استخدام الات الرش وتطبيقات المبيدات وقواعد الامان فى الاستخدام وغطت الاستمارات خمس محافظات بالدلتا والوجه القبلى وتم تحليل نتائجها . كما شمل الجزء الثانى من الدراسة على المعايير والتوصيات التى تدعم التقاليد فى مكافحة آفات البساتين فى ظروف بدئية نظيفة خالية من التلوث لباستخدام بدائل المبيدات قدر المستطاع

اعتمد العمل على فريق بحثى لتكوين الارشادات والتوصيات والحصول على النتائج المرضية من خلال اربع

محاور وهى :

- 1- تشريع طرق الرش بالمبيدات المثلى
- 2- ضبط وتقدير معايير الرش المناسبة واجراء المعايير المتوازنة لالات الرش المختلفة
- 3- الاحتياجات الفنية للرشاشات او وحدات التحزيبى مع عمل اختبارات معدات التصرف لهم بما يناسب ظروف مكافحة كل أفة على الهدف المعامل
- 4- ضرورة فحص الات الرش بصفة دورية بكل مكوناتها مع ضرورة وجود مراكز خدمة ارضية متخصصة للصيانة والمتابعة والفحص والمعايرة

ومن اهم التوصيات التى تحقق الحصول على نتائج مكافحة جيدة للآفات البساتينية ضرورة اخذ قرار فورى نحو اصدار تشريع قانونى رسمى من جهة حكومية يشمل الاشراف على كل مظاهر طرق تطبيقات الرش المستخدمة فى مصر وتشتمل على :

- 1- شهادة كفاءة لكل الة رش
- 2- ترخيص حكومى لمطبقى المبيدات ولصالحه كفاءة الالة المستخدمة من خلال ضبط معايير الرش المناسبة والتي تعطى التغطية المطلوبة والمناسبة للحصول على غطاء رش متجانس لاشجار الفاكهة المعاملة بما يحفظ البيئة من التلوث والحد من الفاقد بالرش بين النباتات
- 3- عمل ملتقيات علمية ارشادية على كل ماهو جديد فى مجال تكنولوجيا الات الرش البساتينية التى تحد من حجوم الرش والحصول على رش متجانس يحفظ البيئة من التلوث